

## CLAIMS

What is claimed is:

1. A performance enhancing break-in method for a proton exchange membrane fuel cell (12), the fuel cell including an anode electrode (14) and a cathode electrode (16) secured to opposed sides of a proton exchange membrane electrolyte (18), the method comprising the steps of:
  - a. cycling a potential of an electrode selected from the group consisting of the anode electrode (14) and the cathode electrode (16) for a first electrode cycle by changing the potential of the selected electrode (14, 16) within a potential range of between 0.00 volts to 1.20 volts from a first potential within the range to a second potential within the range and then changing the potential of the selected electrode (14, 16) from the second potential back to the first potential; and,
  - b. repeating the cycling of the potential of the selected electrode (14, 16) for at least a second electrode cycle.
2. The method of claim 1, further comprising the step of cycling the potential of the selected electrode (14, 16) by applying a direct electrical current to the electrode (14, 16) from a programmable direct current power source (80) to change the potential of the electrode (14, 16) from the first potential to the second potential, and then changing the potential of the electrode (14, 16) back to the first potential.
3. The method of claim 1, further comprising the steps of selecting the cathode electrode (16) from the group of electrodes, cycling the potential of the cathode electrode (16) by lowering the potential of the cathode

5 electrode (16) within the potential range by exposing the  
cathode electrode (16) to an inert gas while exposing the  
anode electrode (14) to a reducing fluid reactant, and  
then raising the potential of the cathode electrode (16)  
within the potential range by exposing the cathode  
10 electrode (16) to an oxidant reactant while continuing to  
expose the anode electrode (14) to the reducing fluid  
reactant.

4. The method of claim 1, further comprising the steps  
of selecting the anode electrode (14) from the group of  
electrodes, cycling the potential of the anode electrode  
(14) by lowering the potential of the anode electrode  
5 (14) within the potential range by exposing the anode  
electrode (14) to a reducing fluid reactant while  
exposing the cathode electrode (16) to an oxidant  
reactant, and then raising the potential of the anode  
electrode (14) within the potential range by exposing the  
10 anode electrode (16) to an inert gas while continuing to  
expose the cathode electrode (16) to the oxidant  
reactant.

5. A performance enhancing break-in method for a proton  
exchange membrane fuel cell (12), the fuel cell including  
an anode electrode (14) and a cathode electrode (16)  
secured to opposed sides of a proton exchange membrane  
electrolyte (18), the method comprising the steps of:

5 a. cycling a potential of the cathode electrode  
(16) for a first cathode cycle by changing the  
potential of the cathode electrode (16) within  
a potential range of between 0.00 volts to 1.20  
10 volts from a first cathode potential within the  
range to a second cathode potential within the  
range and then changing the potential of the

cathode electrode (16) from the second cathode potential back to the first cathode potential;

15        b. repeating the cycling of the potential of the cathode electrode (16) for at least a second cathode cycle;

         c. cycling a potential of the anode electrode (14) for a first anode cycle by changing the

20        potential of the anode electrode (14) from a first anode potential within the potential range of between 0.00 volts to 1.20 volts to a second anode potential within the range and then changing the potential of the anode

25        electrode (14) from the second anode potential back to the first anode potential; and,

         d. repeating the cycling of the potential of the anode electrode (14) for at least a second anode cycle.

6. The method of claim 5, comprising the further steps of cycling the potential of the cathode electrode (16) by applying a direct electrical current to the cathode electrode (16) from a programmable direct current power

5        source (80) to change the potential of the cathode electrode (16) from the first potential to the second potential, and then to change the potential of the cathode electrode (16) back to the first potential, and cycling the potential of the anode electrode (14) by

10        applying a direct electrical current to the anode electrode (14) from the programmable direct current power source (80) to change the potential of the anode electrode (14) from the first potential to the second potential, and then to change the potential of the

15        electrode (14) back to the first potential.

7. The method of claim 5 further comprising the steps of cycling the potential of the cathode electrode (16) by

lowering the potential of the cathode electrode (16) within the potential range by exposing the cathode electrode (16) to an inert gas while exposing the anode electrode (14) to a reducing fluid reactant, and then raising the potential of the cathode electrode (16) within the potential range by exposing the cathode electrode (16) to an oxidant reactant while continuing to expose the anode electrode (14) to the reducing fluid reactant.

8. The method of claim 5, further comprising the steps of cycling the potential of the anode electrode (14) by lowering the potential of the anode electrode (14) within the potential range by exposing the anode electrode (14) to a reducing fluid reactant while exposing the cathode electrode (16) to an oxidant reactant, and then raising the potential of the anode electrode (14) within the potential range by exposing the anode electrode (16) to an inert gas while continuing to expose the cathode electrode (16) to the oxidant reactant.

9. The method of claim 5, further comprising the steps of, after the cycling the potential of the cathode electrode (16) step and the cycling the potential of the anode electrode (14) step, calibrating performance of the fuel cell (12) by a performance calibration step by exposing the anode electrode (14) to a reducing fluid reactant and exposing the cathode electrode (16) to an oxidant reactant, then closing a primary load switch (78) to connect a primary load (74) to the anode and cathode electrodes (14, 16) for a predetermined duration, then opening the primary load switch (78) after the duration, and then repeating the performance calibration step a predetermined number of repetitions.

10. A fuel cell system (10) for enhancing a break-in of a proton exchange membrane fuel cell (12), the system comprising:

- 5           a. at least one fuel cell (12) including an anode electrode (14) and a cathode electrode (16) secured to opposed sides of a proton exchange membrane electrolyte (18);
- 10           b. a programmable direct current power source (80) including polarity reversing means (82) connected to a power circuit (70) secured in electrical communication with the anode electrode (14) and the cathode electrode (16) for selectively connecting a positive terminal (84) of the power source (80) to either the  
15           anode electrode (14) or the cathode electrode (16); and,
- 20           c. a reducing fluid source (34, 52) and an inert gas source (40, 58) secured in fluid communication with an anode flow field (20) adjacent the anode electrode (14) and with a cathode flow field (22) adjacent the cathode electrode (16), and valve means for selectively directing flow from the sources of a fluid selected from the group of fluids consisting of  
25           a reducing fluid, an inert gas, and a mixture of a reducing fluid and an inert gas to the anode flow field (20), and for selectively directing flow of a fluid selected from the group of fluids to the cathode flow field (22).

11. A fuel cell system (10) for enhancing a break-in of a proton exchange membrane fuel cell (12), the system comprising:

- a. at least one fuel cell (12) including an anode

5 electrode (14) and a cathode electrode (16)  
secured to opposed sides of a proton exchange  
membrane electrolyte (18);  
b. a reducing fluid source (34, 52), an inert gas  
source (40, 58) and an oxidant source (46, 44)  
10 secured in fluid communication with an anode  
flow field (20) adjacent the anode electrode  
(14) and with a cathode flow field (22)  
adjacent the cathode electrode (16), and valve  
means for selectively directing flow from the  
15 sources of a fluid selected from the group of  
fluids consisting of a reducing fluid, an inert  
gas, a mixture of a reducing fluid and an inert  
gas, and an oxidant to the anode flow field  
(20), and for selectively directing flow of a  
20 fluid selected from the group of fluids to the  
cathode flow field (22).